FIG.1

COMPARISON BETWEEN CHARACTERISTICS OF KINETIC FUNCTION MATERIALS

	HIGH POLYMER GEL		SHAPE MEMORY ALLOY[5]	PIEZOELECTRIC CERAMIC ELEMENT[4]	RUBBER ARTIFICIAL MUSCLE[4]	INTERCALATION MATERIAL[2]	BIOMUSCLE[3]
	Ionic polymer-metal composites[1]	GEL PRODUCED BY FREEZING-DEFROSTING METHOD[3]					
DISPLACEMENT	20 – 30%		8%	0.1%	20%	[Amino-TiNb05] SEVERAL TIMES (REACTION DRIVE TYPE) 30% ELECTRIC FIELD DRIVE TYPE)	50%
FORCE (MPa)	10 – 30	–	588	300			0.5-1
SPEED OF RESPONSE	>0.2 sec		sec to min	μsec			0.03-0.2sec
DRIVE METHOD	APPLICATION OF VOLTAGE (4-7 V)	CHANGE IN SOLUTION	CHANGE IN TEMPERATURE	APPLICATION OF VOLTAGE (50-800V)	CHANGE IN PNEUMATIC PRESSURE	CHANGE IN SOLUTION (APPLICATION OF VOLTAGE)	
OUTPUT-WEIGHT RATIO	–	01.W/g	0.1W/g				0.1-0.3W/g
LABORATORY	NEW MEXICO UNIVERSITY	MECHANICAL TECHNOLOGY RESEARCH	NAGAOKA TECHNOLOGY/SCIENCE UNIVERSITY		BRIDGESTONE CORPORATION		

1 "Ionic Polymer-Metal Composites (IPMC) As Biomimetic Sensors, Actuators and Artificial Muscles-A Reviw" M.Shahinpoor et al. (University of New-Mexico) http:/www.unm.edu/-amri/paper.html
2 "ORGANIC INTERCALATION ON LAYERED COMPOUND KTiNbO5" S.KIKKAWA and M.KOIZUMI (Osaka Univ.) Physica 105B (1981) 234
3 "ARTIFICIAL MUSCLE", MAKOTO SUZUKI (MECHANICAL TECHNOLOGY RESEARCH), APPLIED PHYSICS, 60(1991)256
4 "ACTUATOR PRACTICAL DICTIONARY", SUPERVISED BY SHOUTAROU MIYAIRI, FUJI TECHNO SYSTEM (1988)
5 "ARTIFICIAL MUSCLE" EDITED BY HITOSHI MIYAKE, KAMEDA BOOK SERVICE (1998)

FIG. 2

DIFFERENCE BETWEEN ELECTROMAGNETIC WAVE AND SOUND WAVE IN TERMS OF WAVELENGTH

	NAME OF SOUND WAVE (ULTRASONIC WAVE)	WAVELENGTH, λ	NAME OF ELECTROMAGNETIC WAVE	
1GHz		380nm	VISIBLE LIGHT RAY	
	VERY HIGH FREQUENCY ULTRASONIC WAVE	780nm	NEAR INFRARED RADIATION	
		1.5μm	MID INFRARED RADIATION	
		5μm	FAR INFRARED RADIATION	
		100μm		3THz
1MHz	HIGH FREQUENCY ULTRASONIC WAVE		VERY FAR INFRARED RADIATION	
		1mm		300GHz
	LOW FREQUENCY ULTRASONIC WAVE		MILLIMETER WAVE	
20KHz		1cm		30GHz
	AUDIBLE SOUND WAVE (HIGH TEMPERATURE)		MICROWAVE	
		10cm		3GHz
			SUPERHIGH HIGH FREQUENCY WAVE	
		1m		300MHz
	AUDIBLE SOUND WAVE (LOW TEMPERATURE)		VERY HIGH FREQUENCY WAVE	
20Hz		10m		30MHz
	LOW FREQUENCY WAVE		HIGH FREQUENCY WAVE	

FIG.3

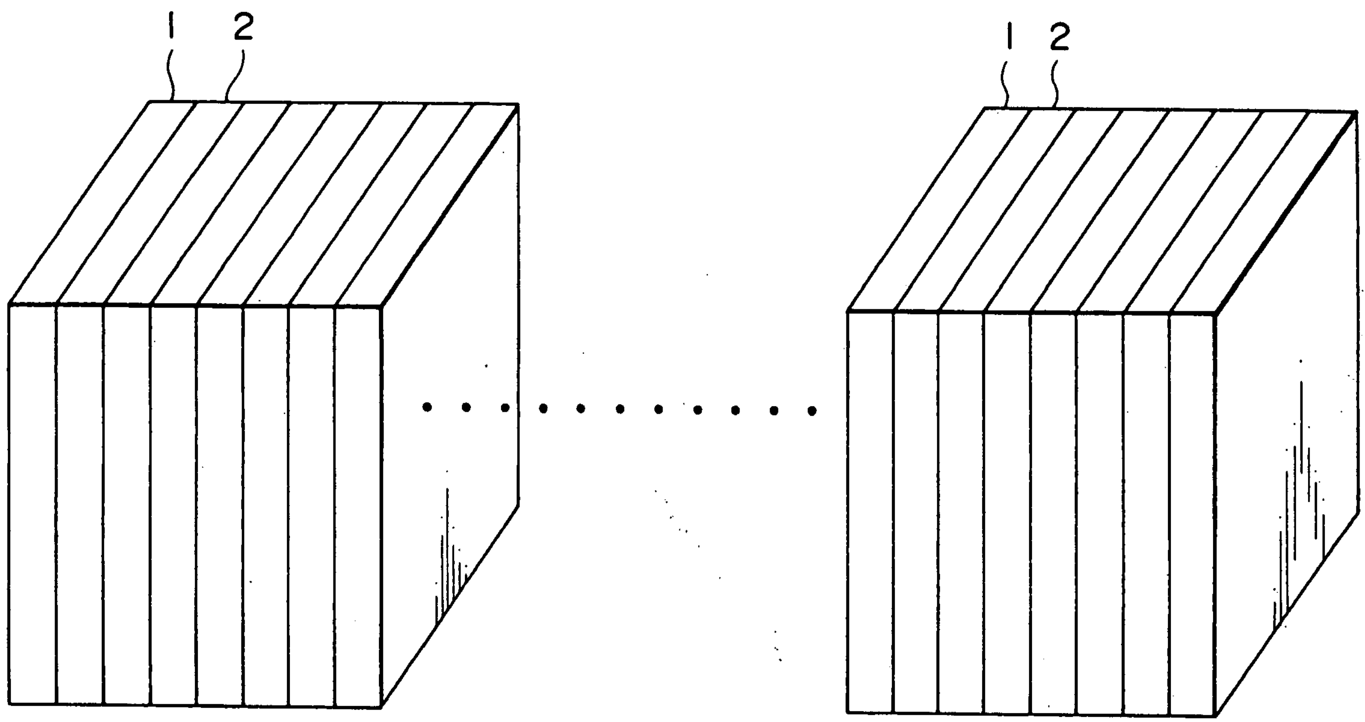


FIG. 4

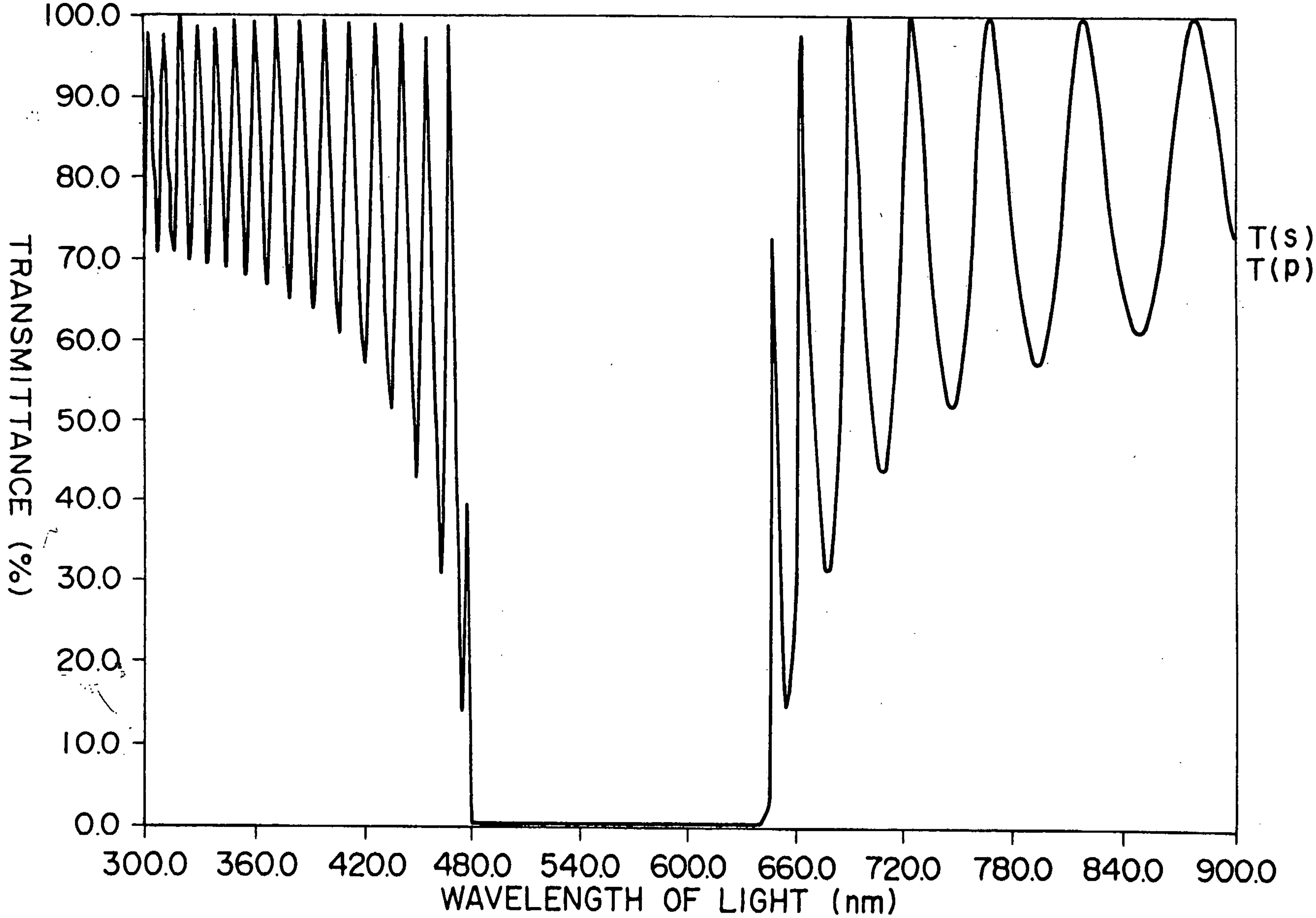
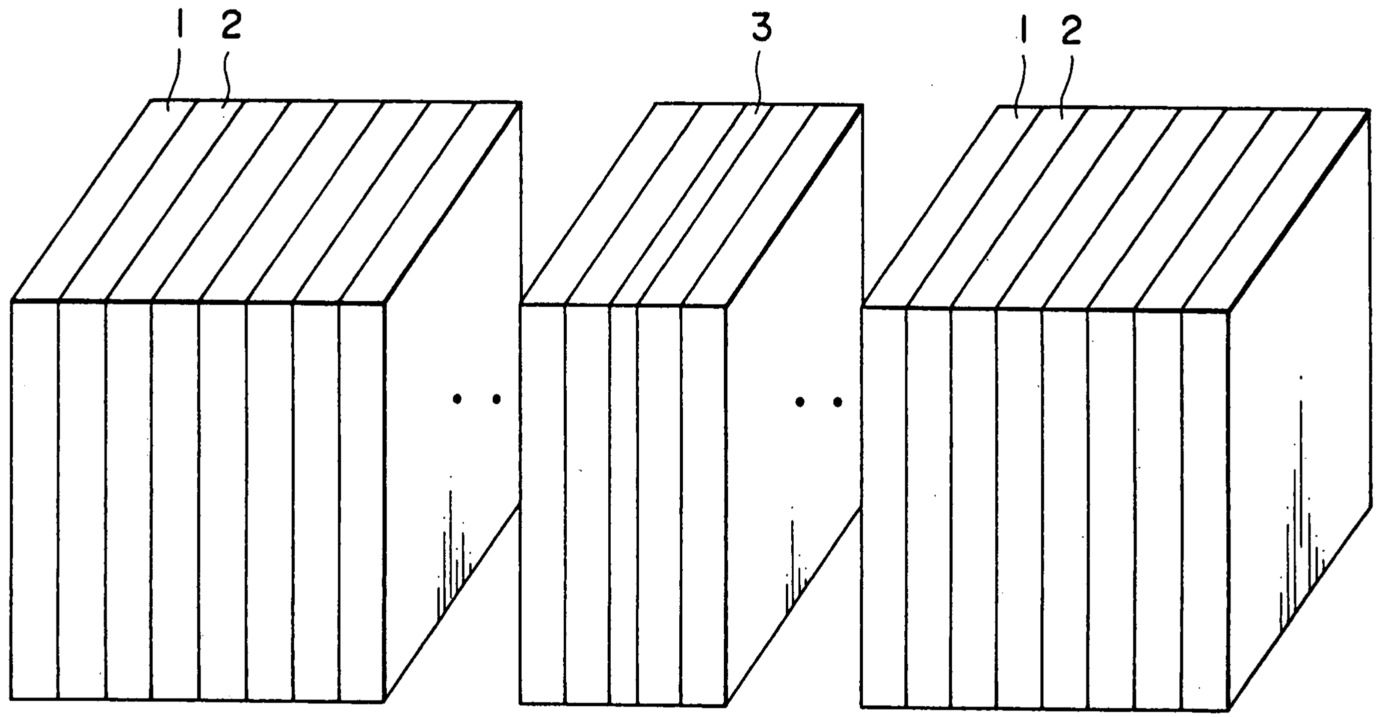
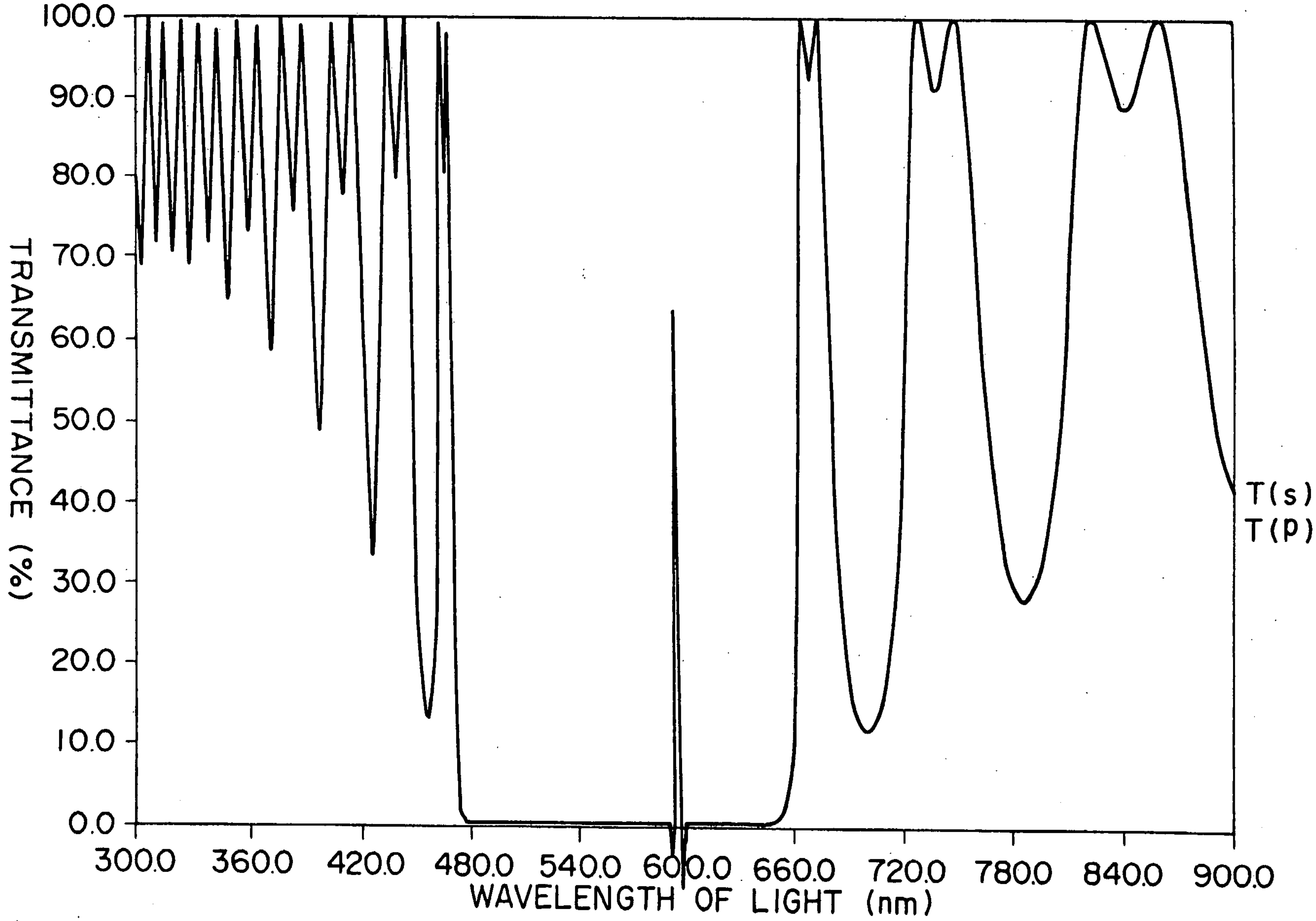

100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
TRANSMITTANCE (%)
300.0
360.0
420.0
480.0
540.0
600.0
660.0
720.0
780.0
840.0
900.0
WAVELENGTH OF LIGHT (nm)
T(s)
T(p)

FIG.5



F I G. 6



100.0
90.0
80.0
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
TRANSMITTANCE (%)
300.0
360.0
420.0
480.0
540.0
600.0
660.0
720.0
780.0
840.0
900.0
WAVELENGTH OF LIGHT (nm)
T(s)
T(p)

FIG.7A

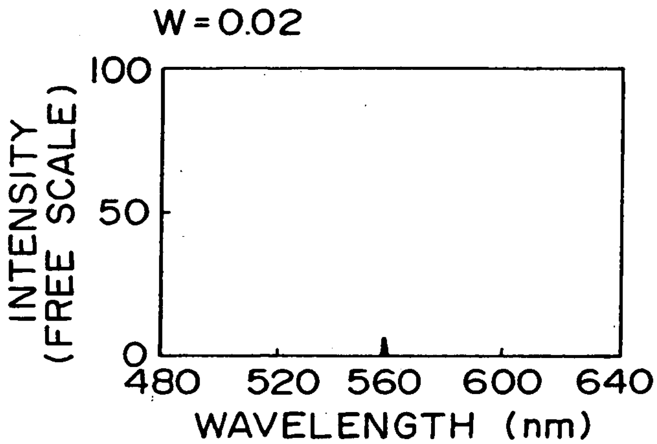


FIG.7B

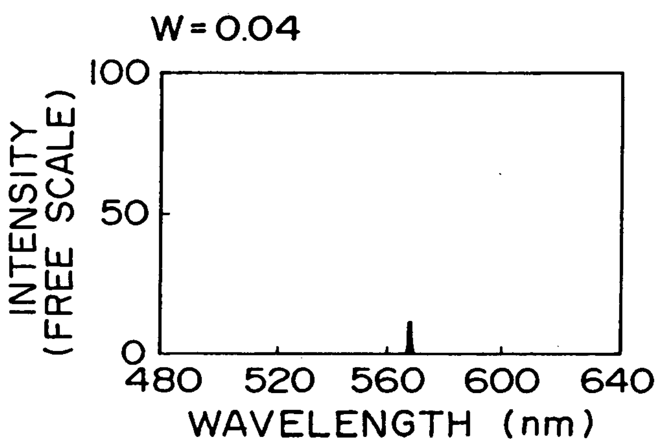


FIG.7C

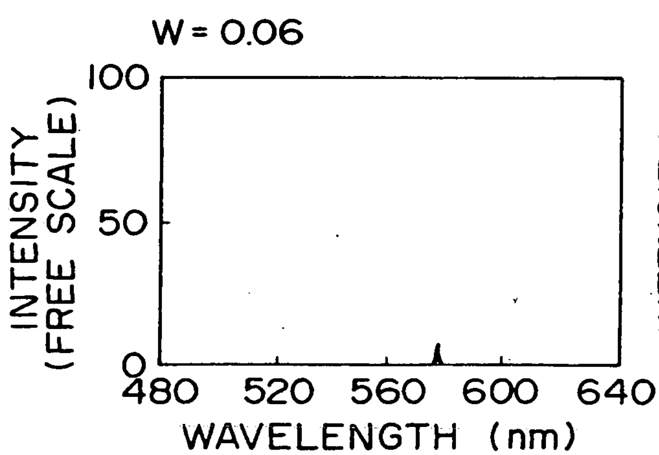


FIG.7D

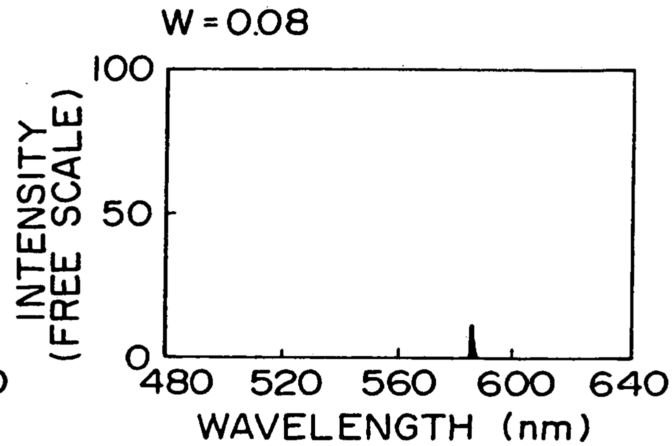


FIG.7E

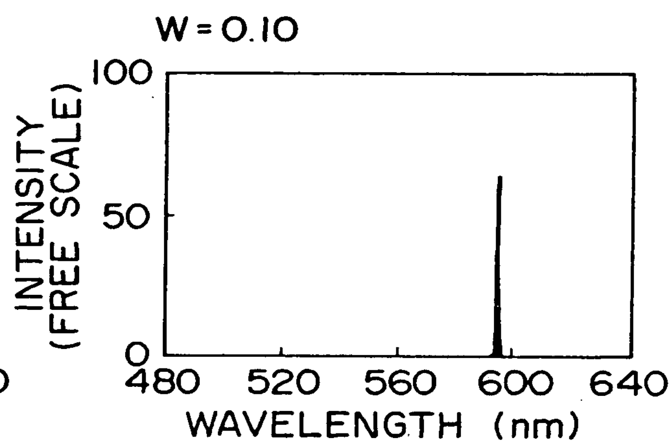


FIG.7F

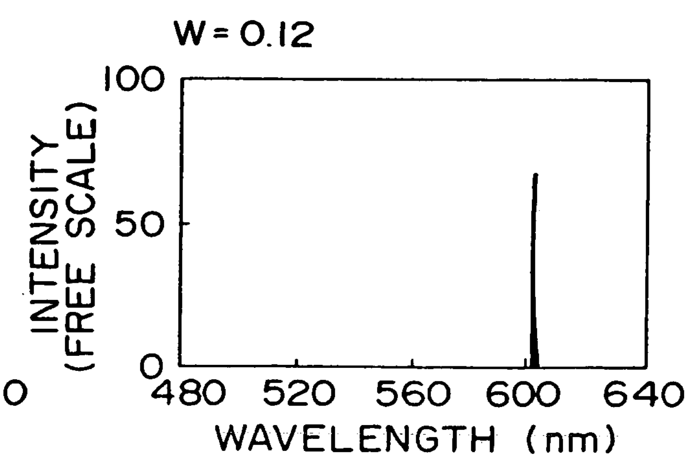


FIG. 8A

W = 0.14

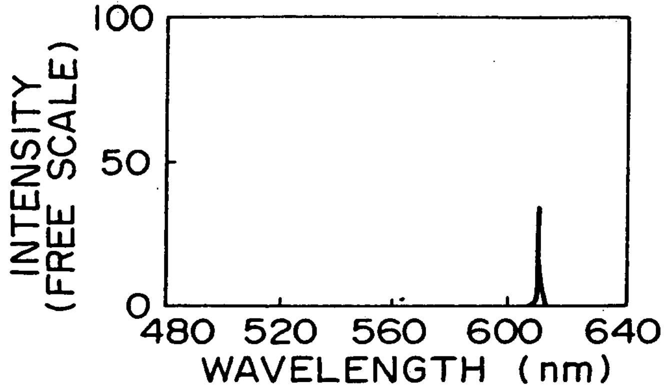


FIG. 8D

W = 0.20

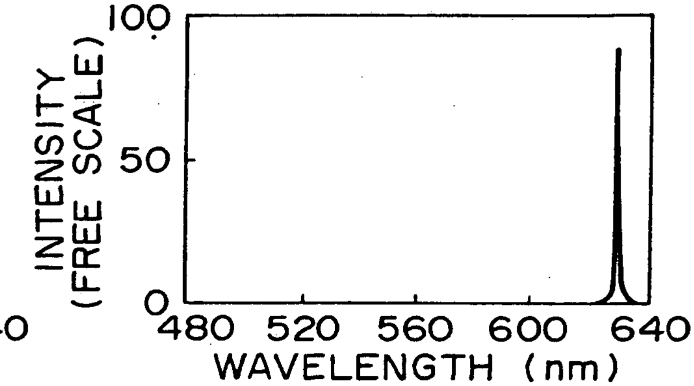


FIG. 8B

W = 0.16

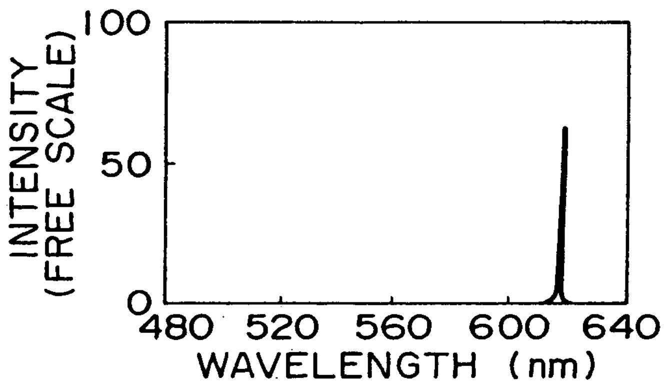


FIG. 8E

W = 0.22

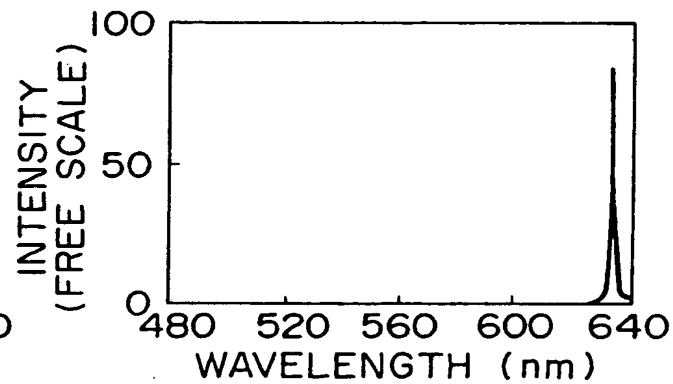


FIG. 8C

W = 0.18

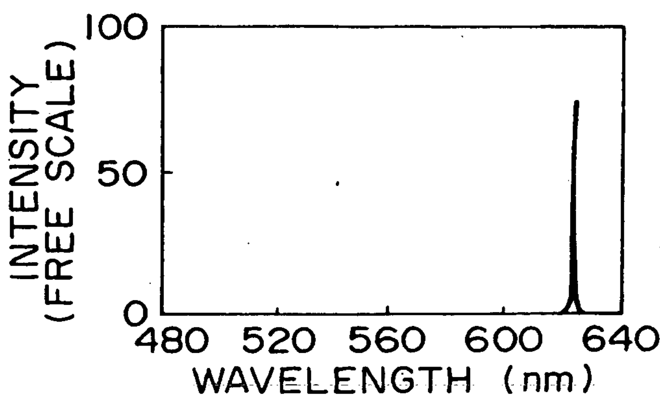


FIG. 8F

W = 0.24

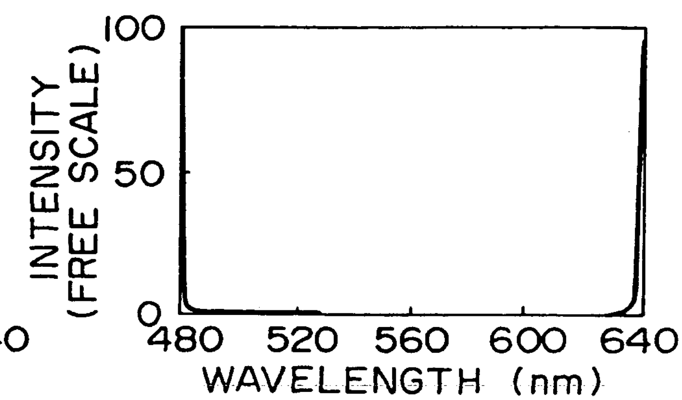
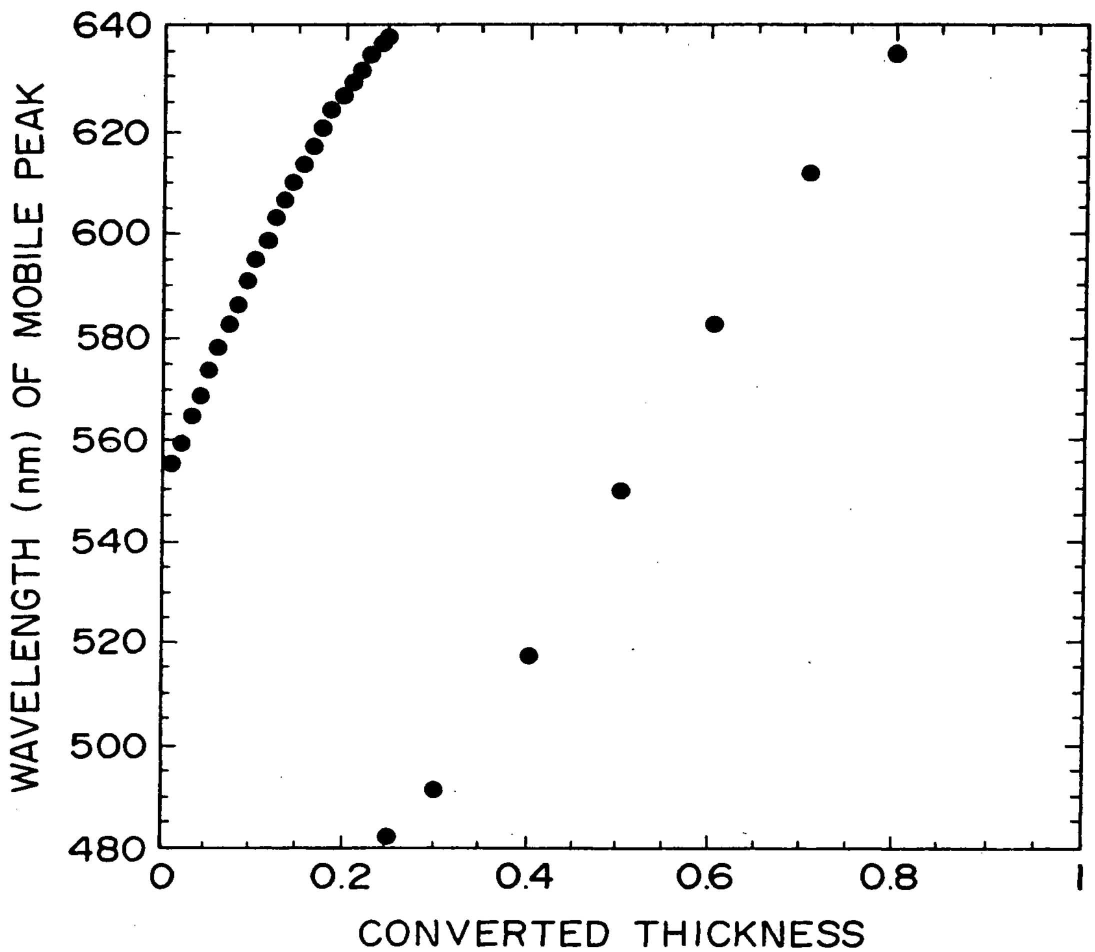


FIG. 9



WAVELENGTH (nm) OF MOBILE PEAK
640
620
600
580
560
540
520
500
480
0
0.2
0.4
0.6
0.8
1
CONVERTED THICKNESS

FIG. 10

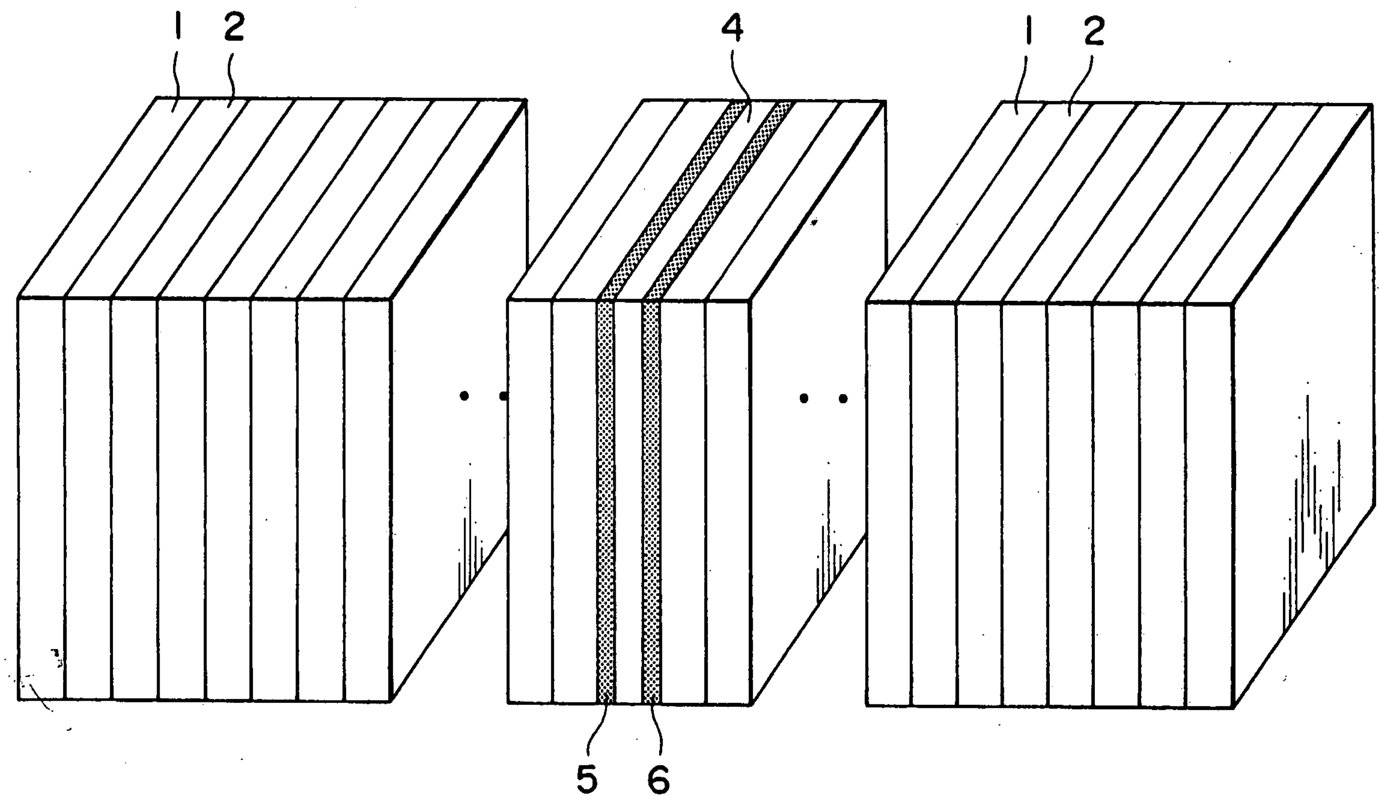
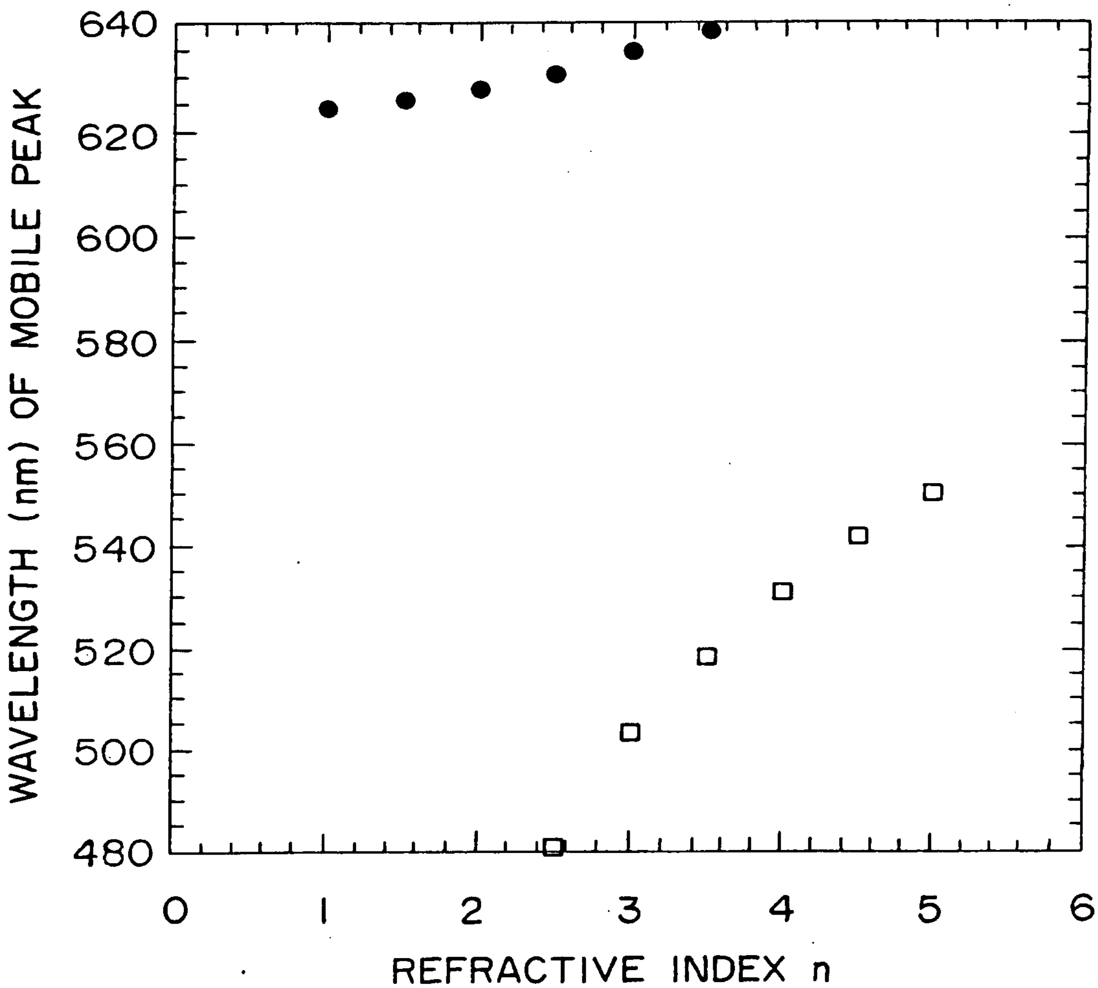
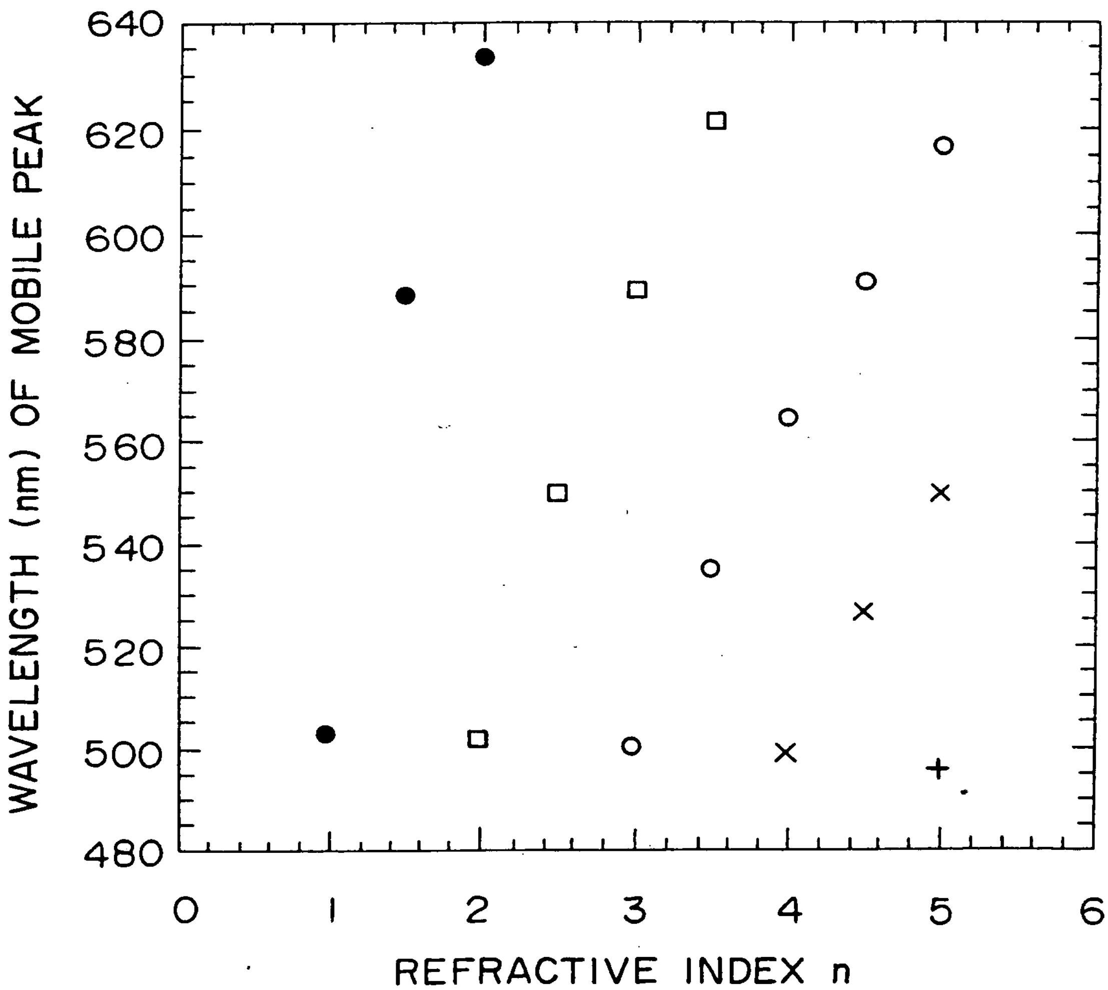


FIG. 11



640
620
600
580
560
540
520
500
480
0
1
2
3
4
5
6
WAVELENGTH (nm) OF MOBILE PEAK
REFRACTIVE INDEX n

FIG. 12



640
620
600
580
560
540
520
500
480
WAVELENGTH (nm) OF MOBILE PEAK
0
1
2
3
4
5
6
REFRACTIVE INDEX n

FIG. 13A

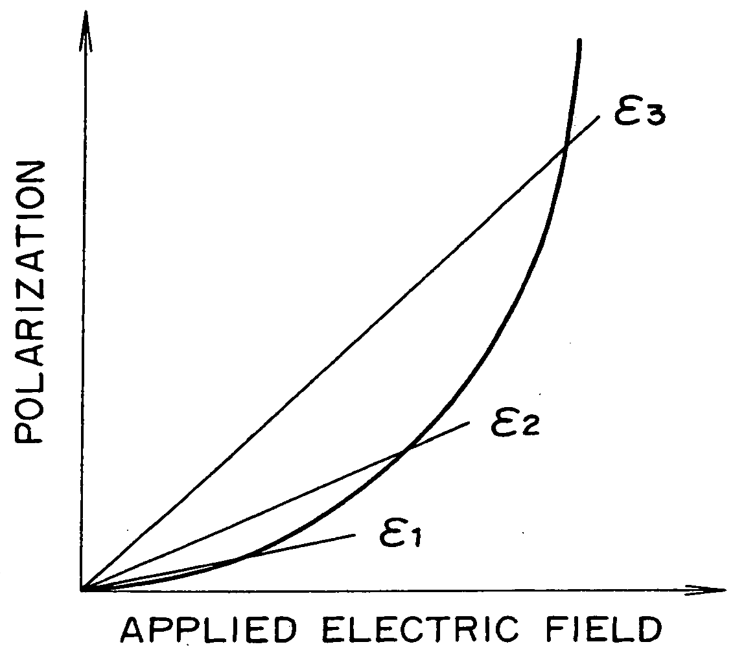


FIG. 13B

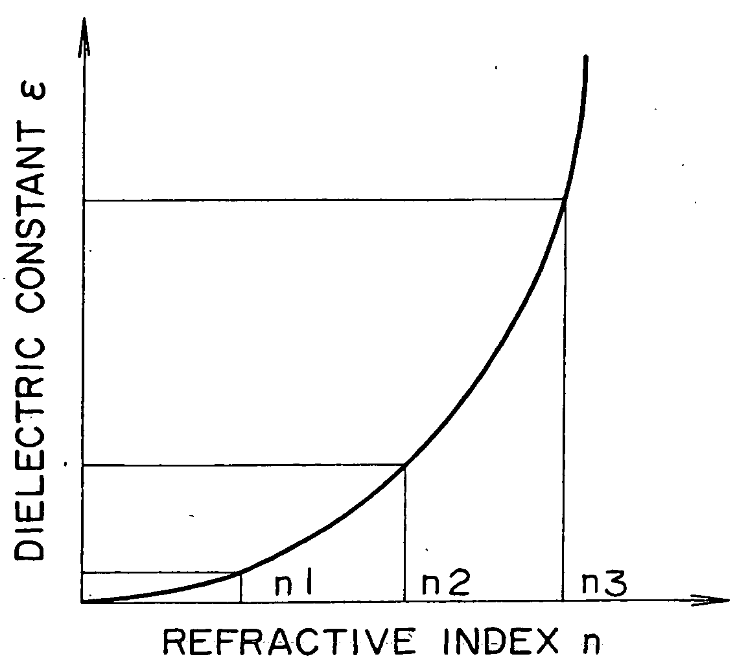


FIG. 14

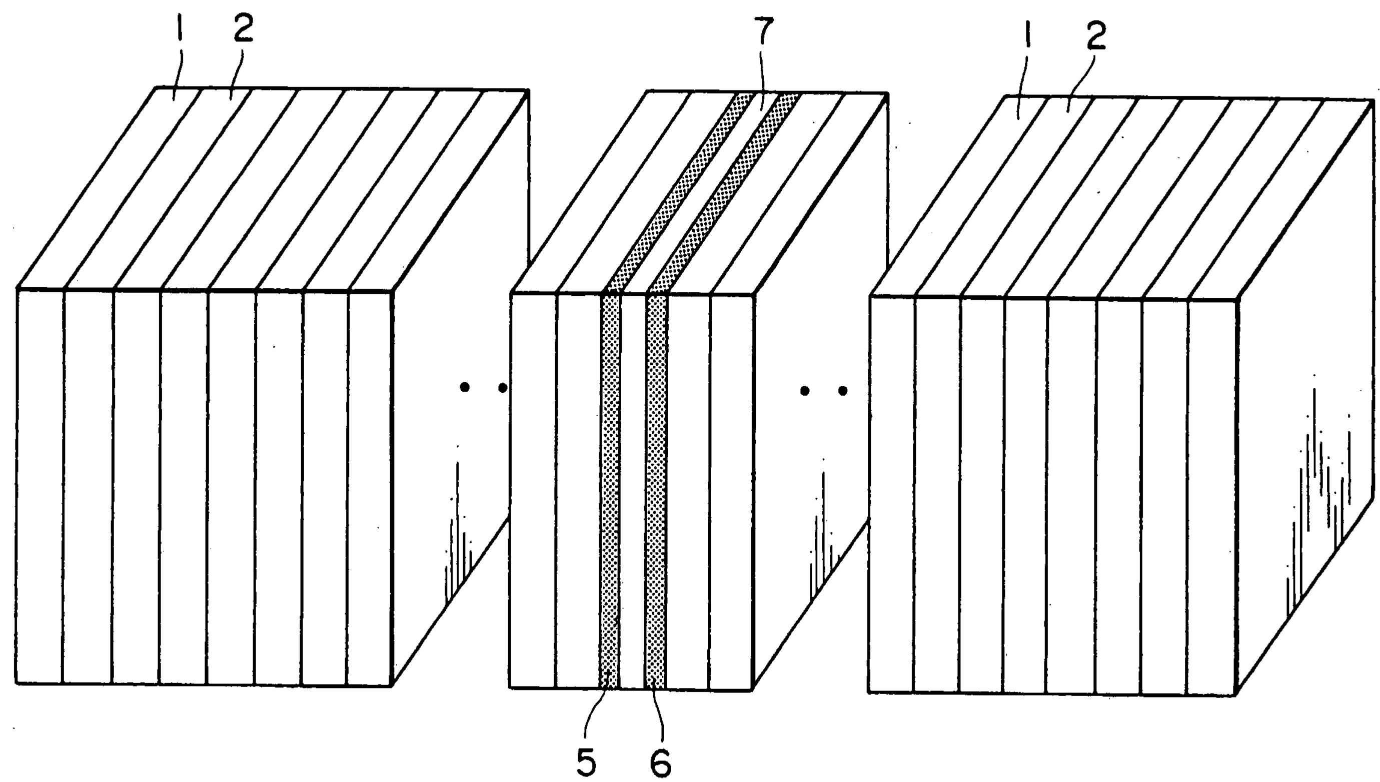


FIG. 15

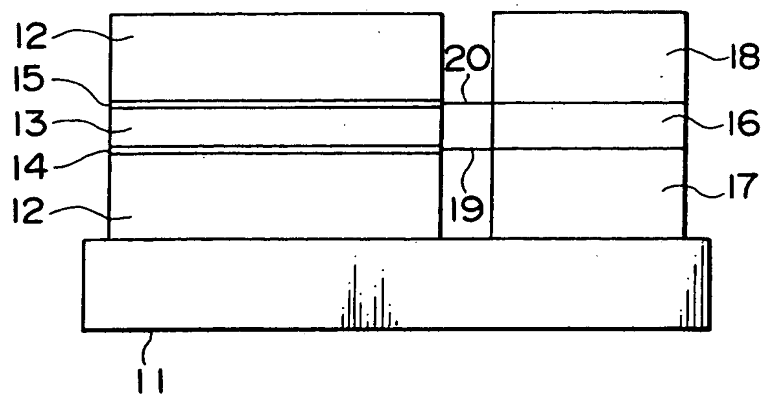


FIG. 16

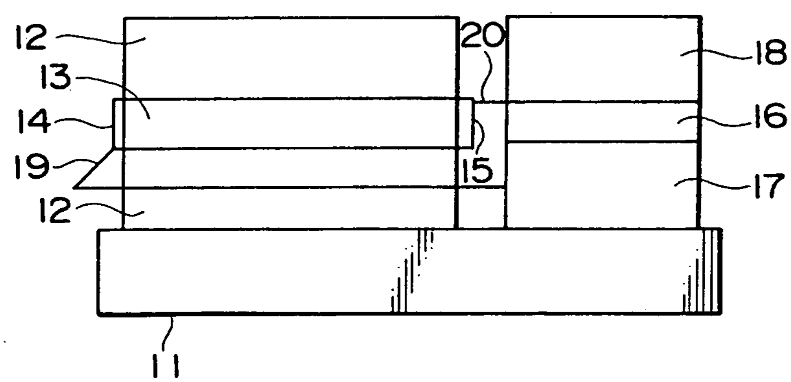


FIG. 17

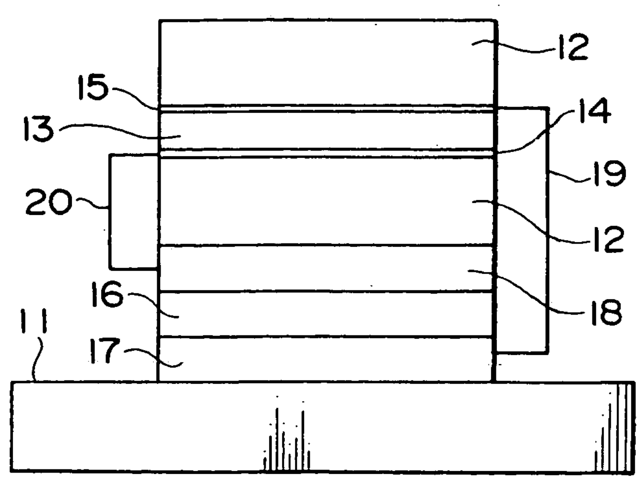


FIG. 18

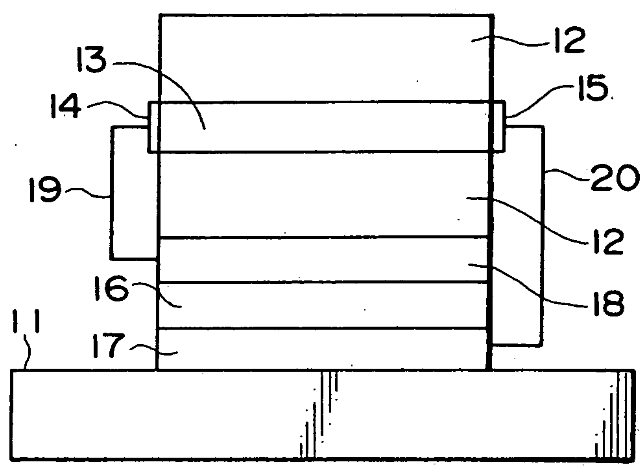


FIG. 19

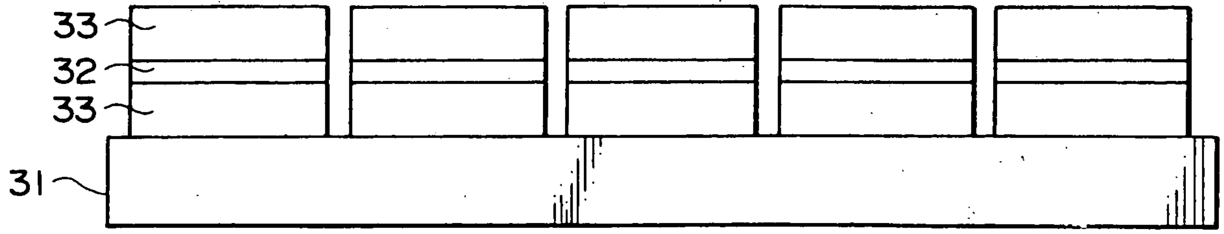


FIG. 20

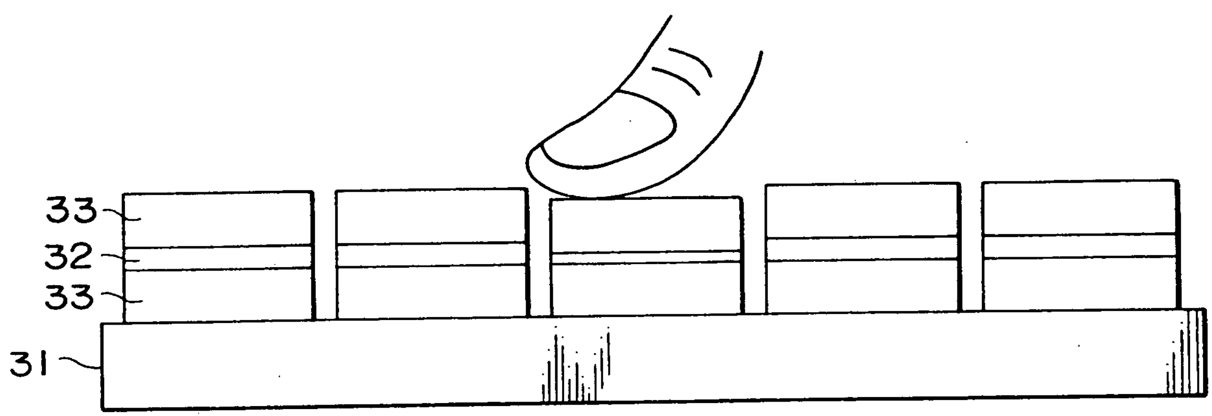


FIG. 21

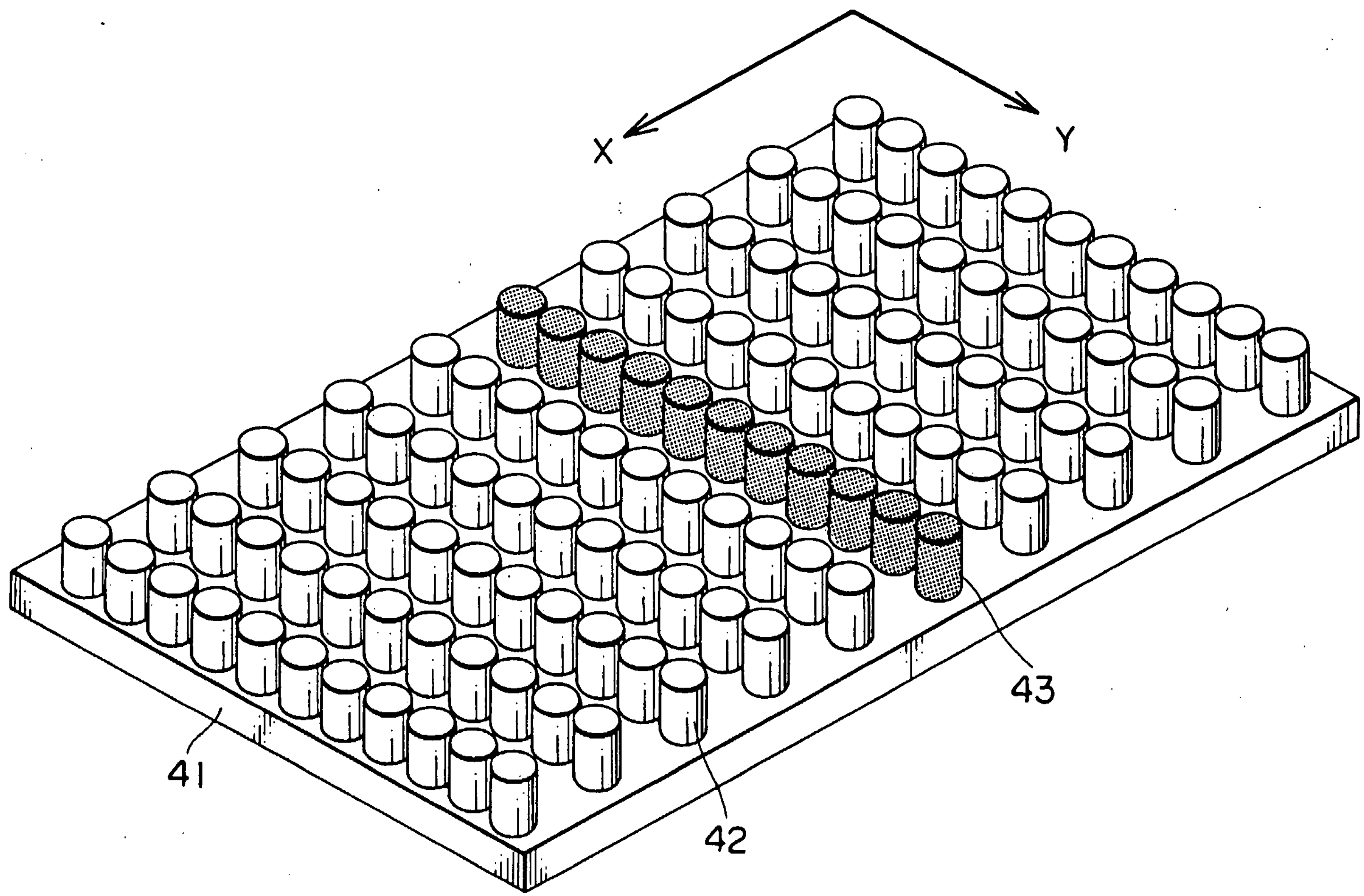


FIG.22A

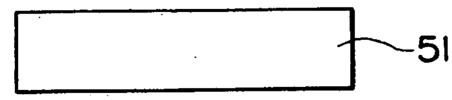


FIG.22B

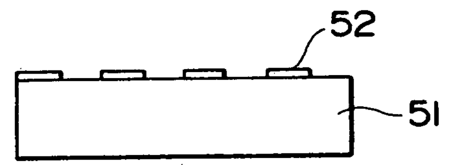


FIG.22C

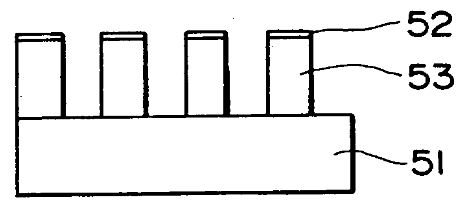


FIG.22D

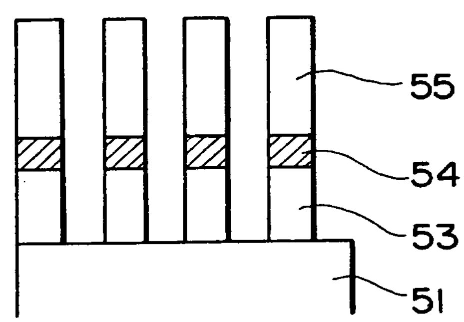


FIG.23

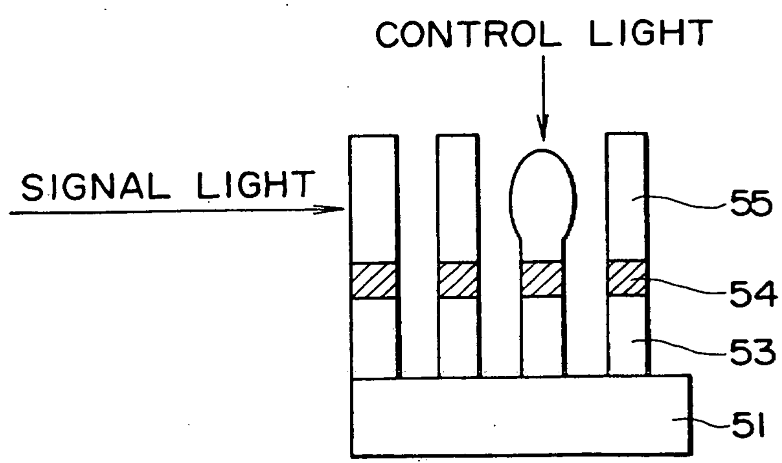


FIG.24A

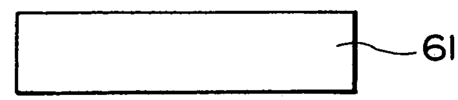


FIG.24B

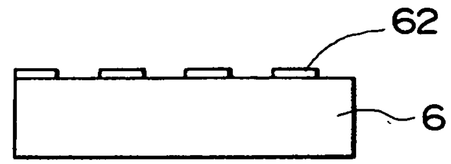


FIG.24C

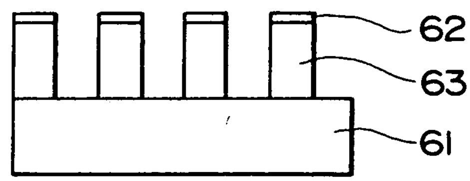


FIG.24D

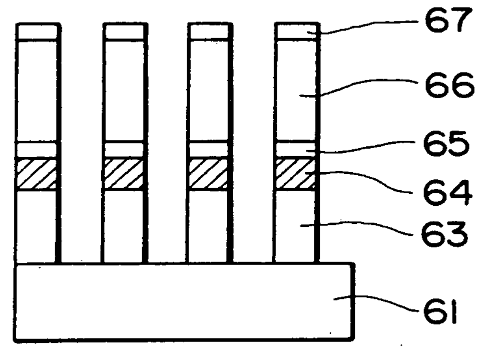


FIG.25

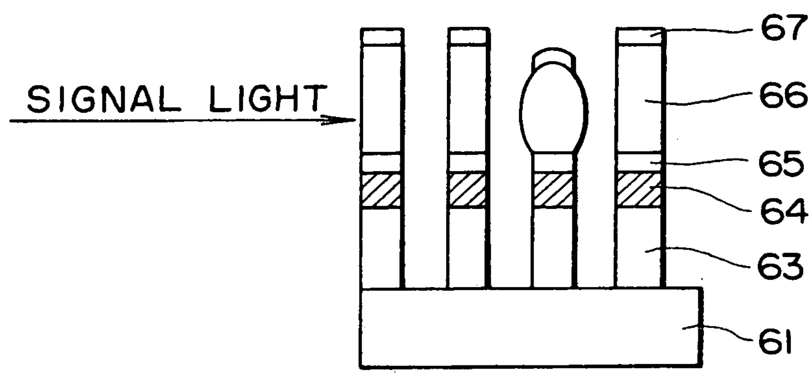


FIG.26

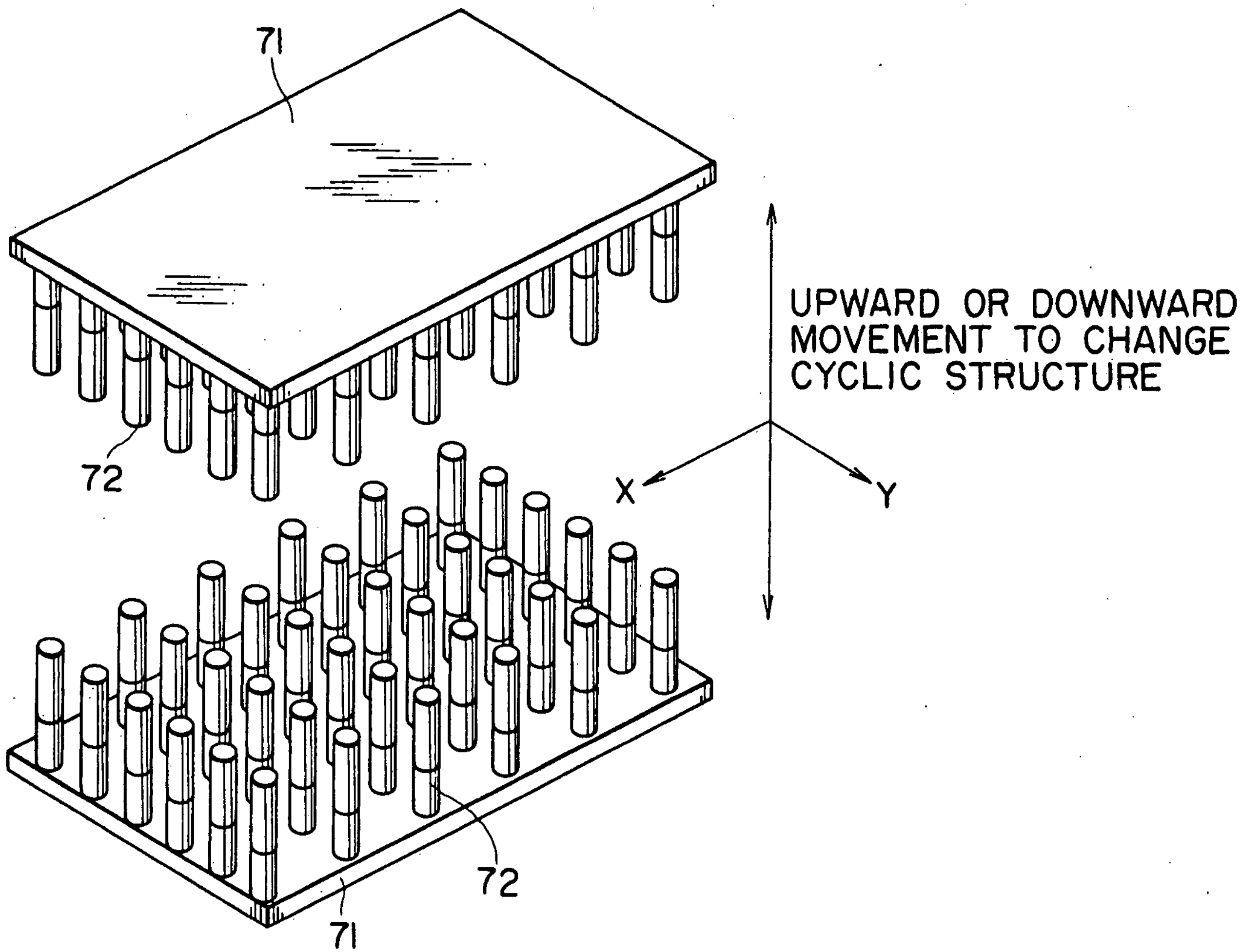

71
72
UPWARD OR DOWNWARD
MOVEMENT TO CHANGE
CYCLIC STRUCTURE
X
Y
72
71

FIG.27

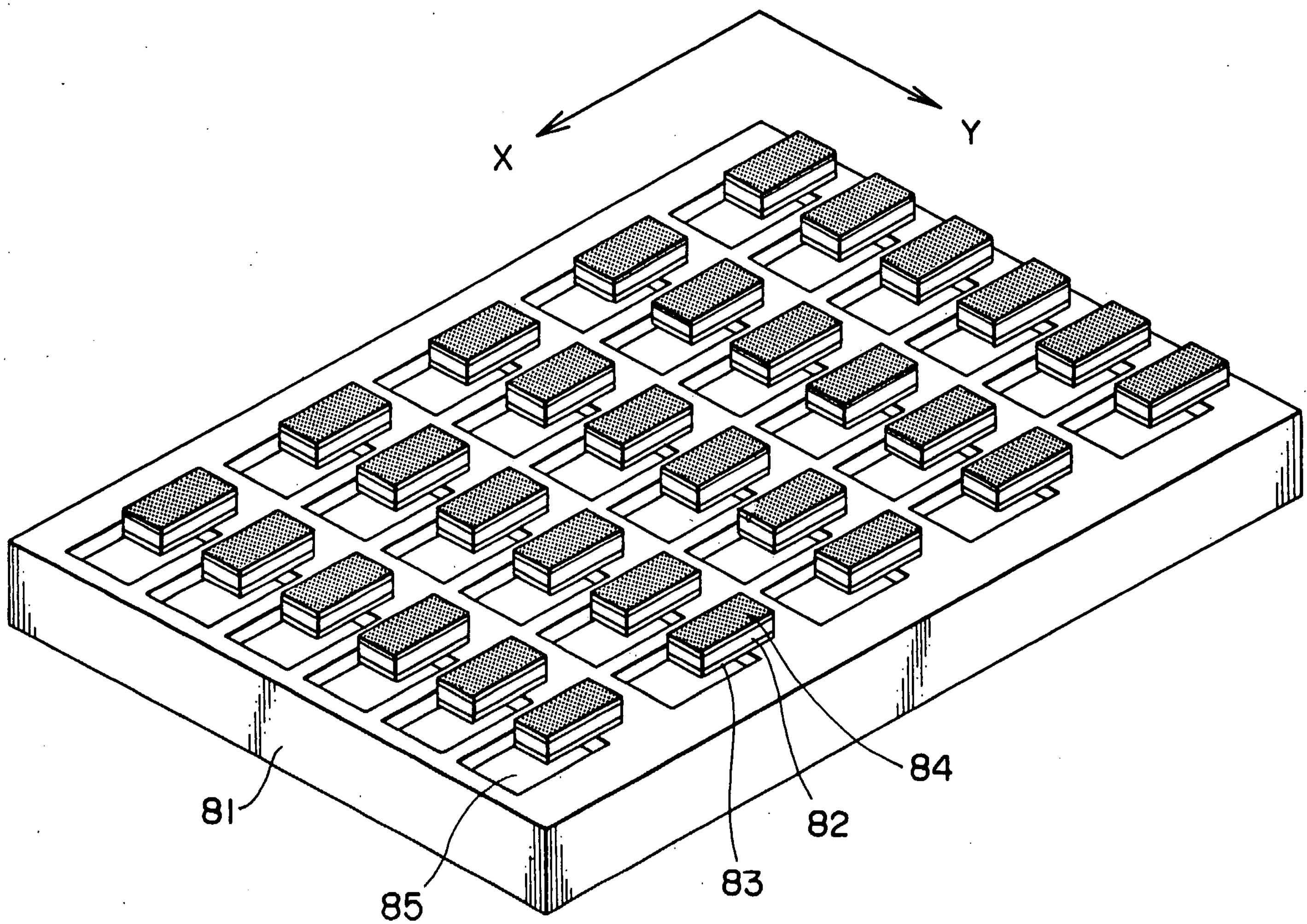


FIG.28

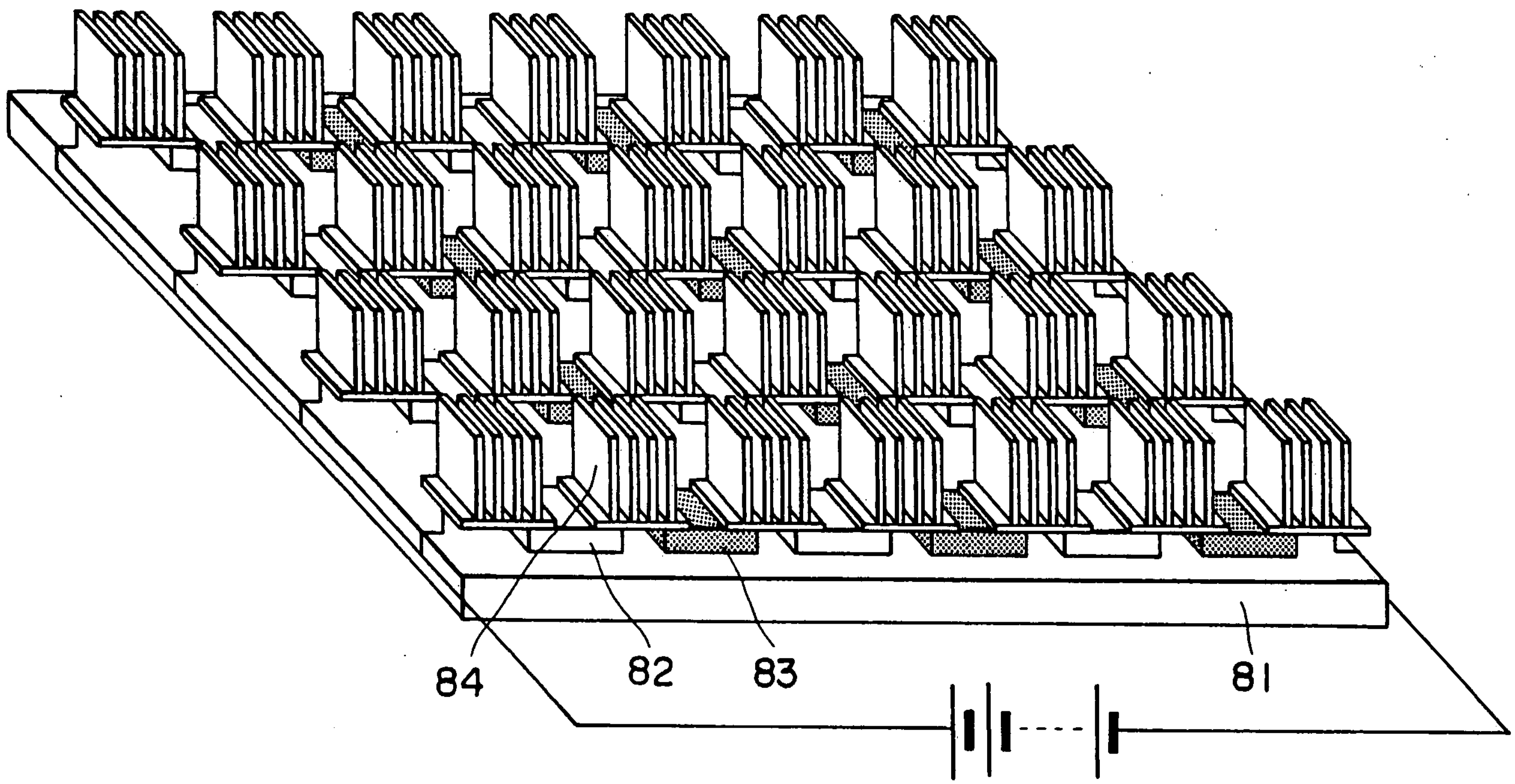


FIG. 29

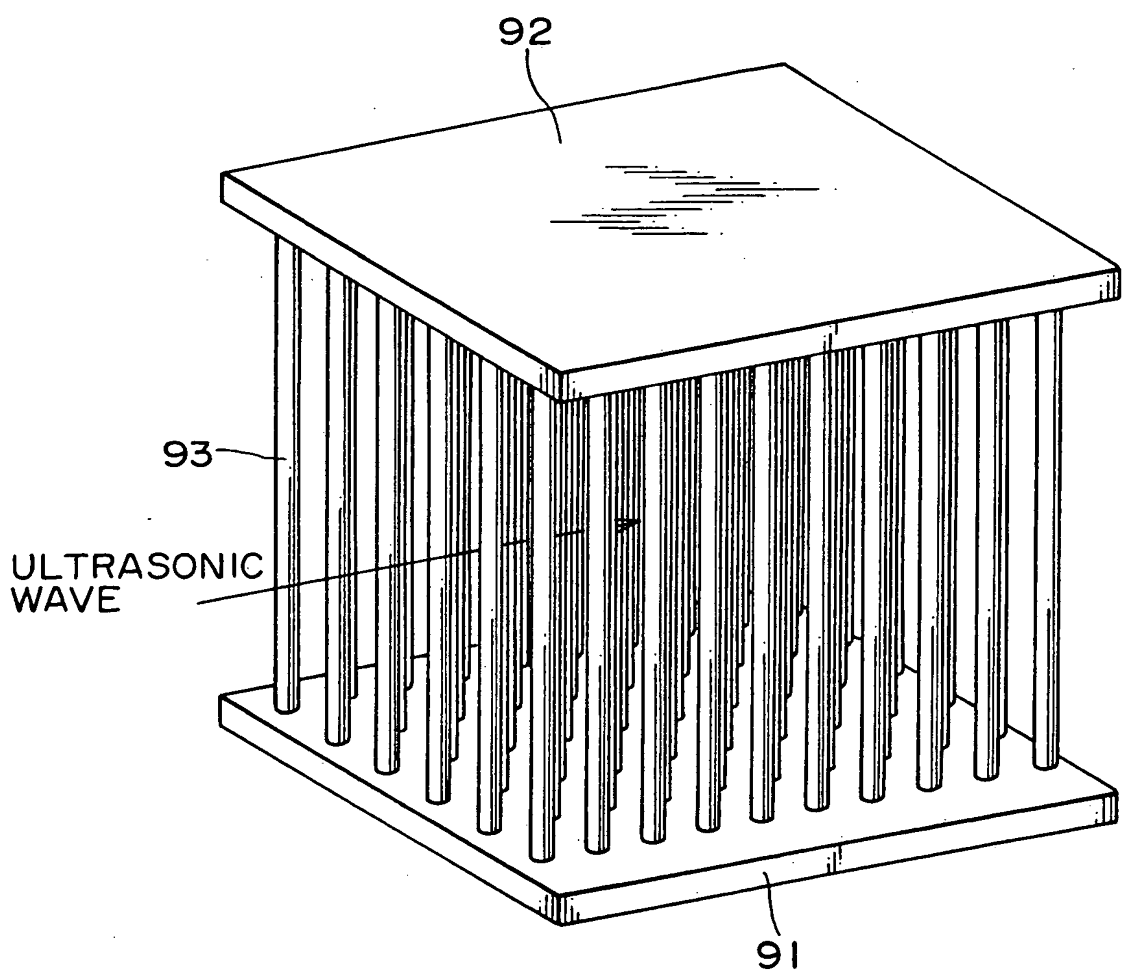
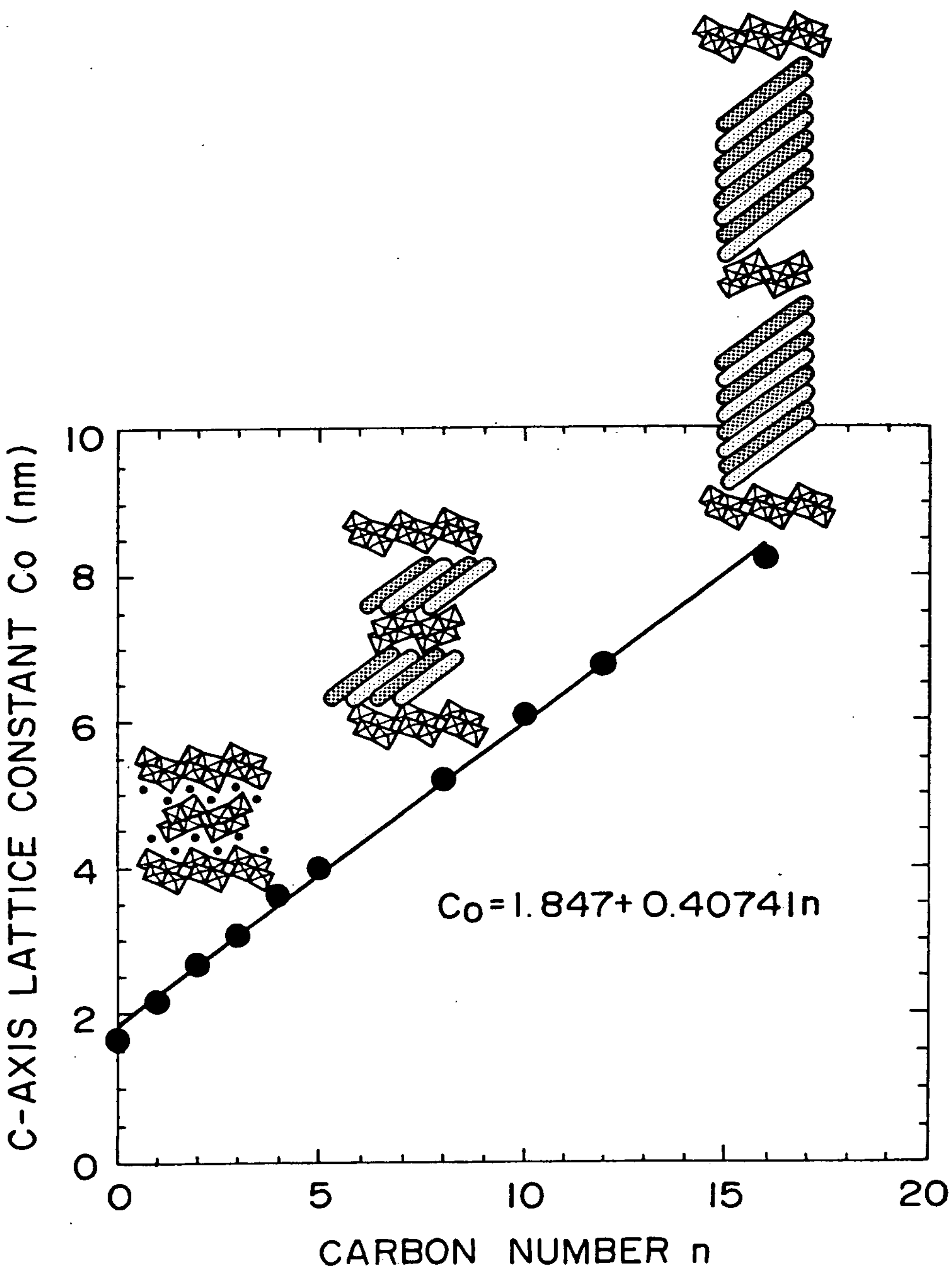


FIG. 30



C-AXIS LATTICE CONSTANT Co (nm)
0
2
4
6
8
10
0
5
10
15
20
CARBON NUMBER n
Co=1.847+0.40741n

FIG. 31

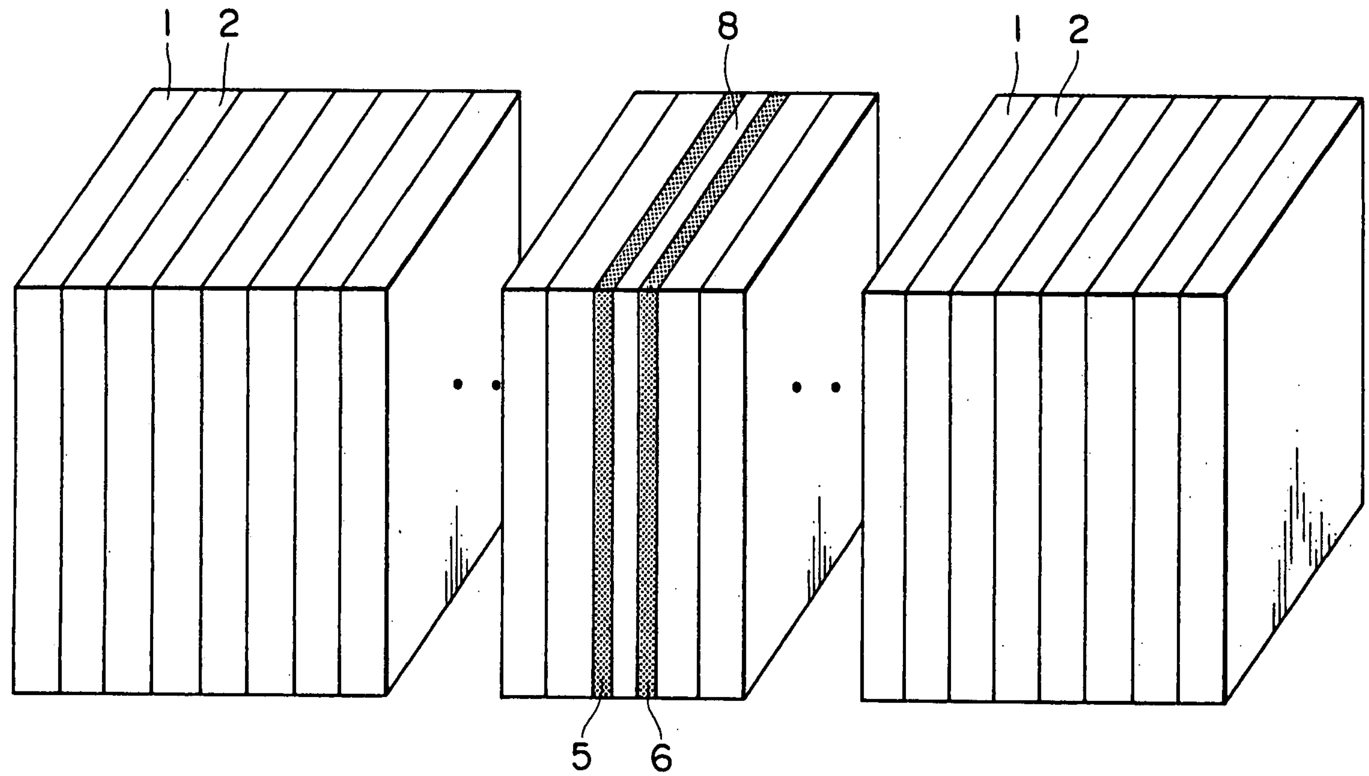


FIG.32

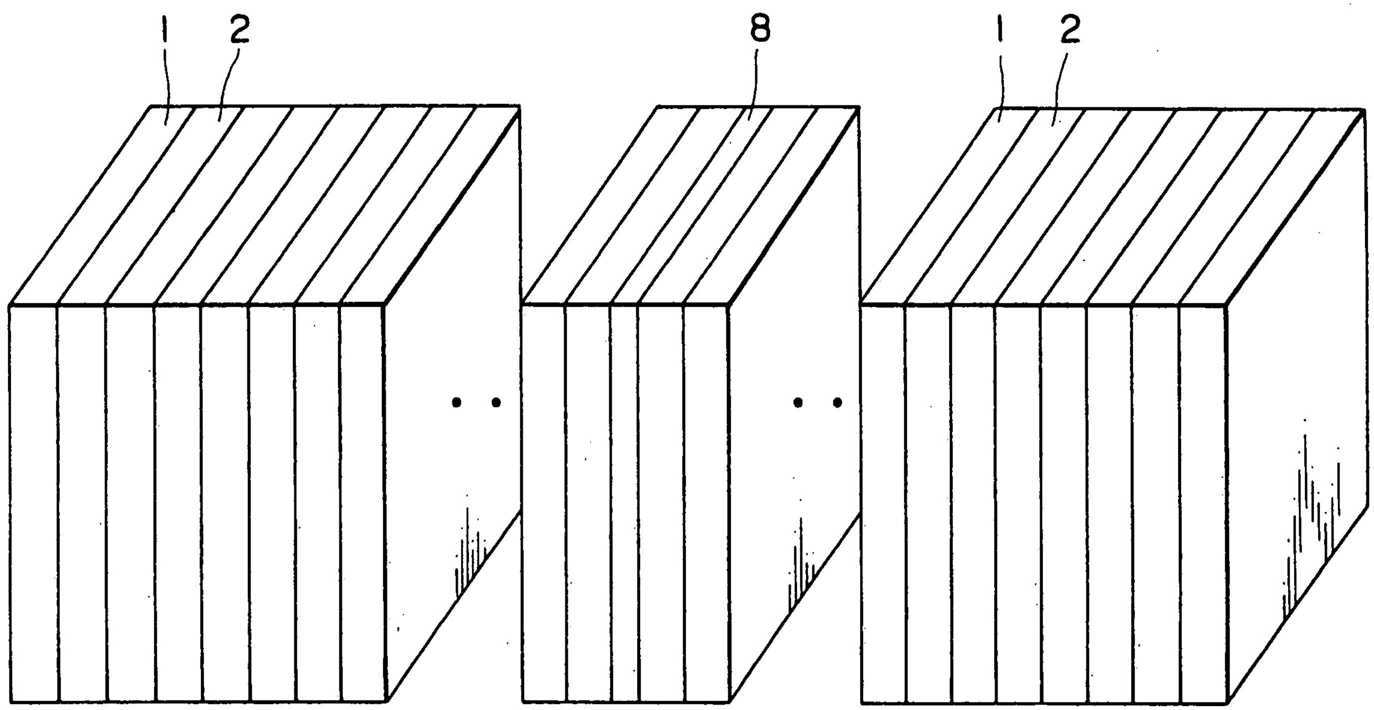


FIG.33

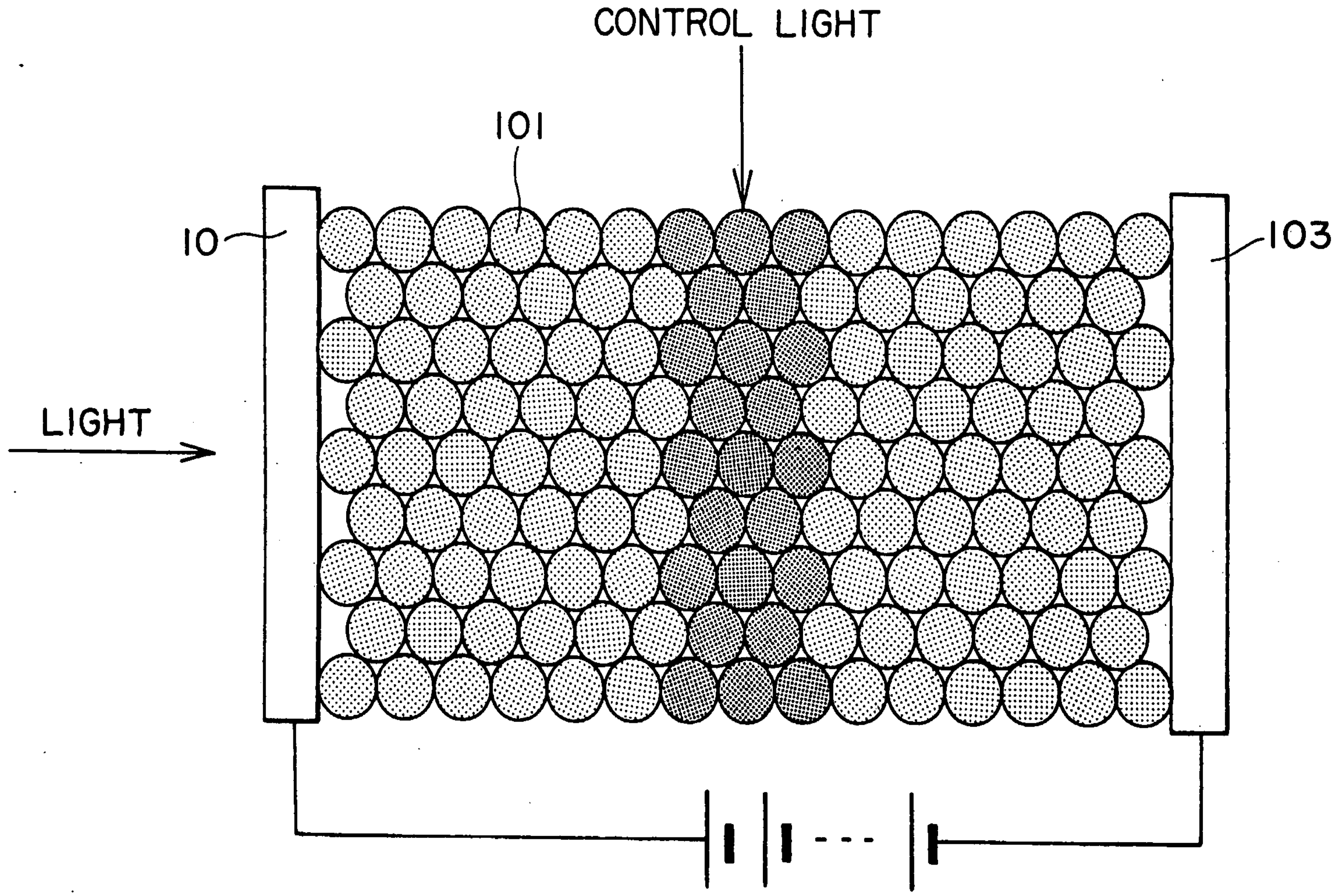


FIG. 34A

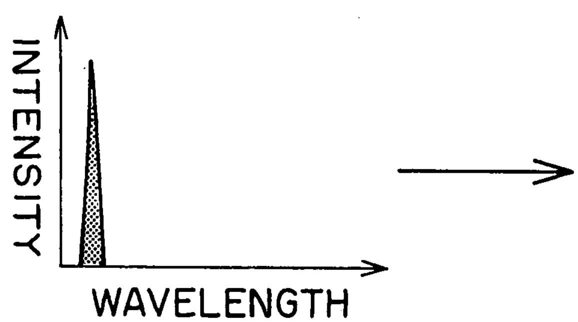


FIG. 34B

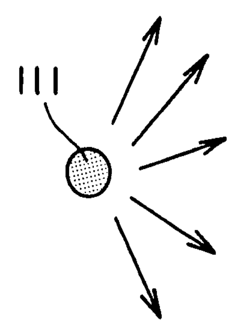


FIG. 34C

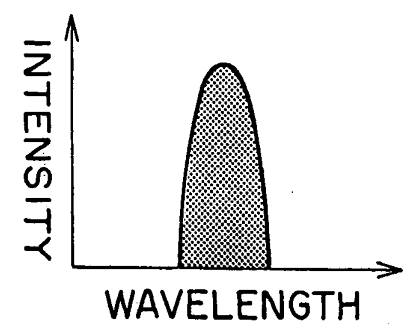


FIG. 35A

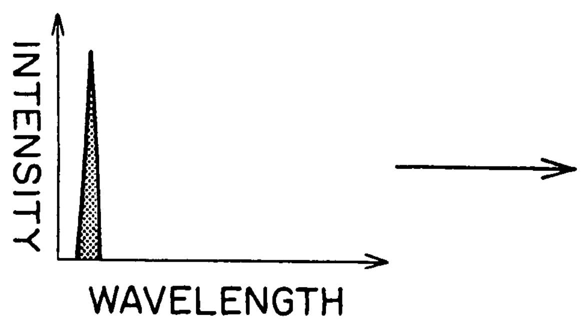


FIG. 35B

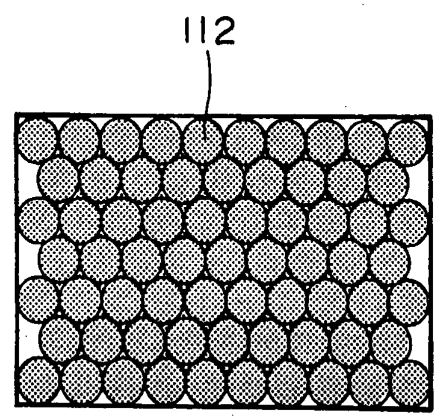


FIG. 35C

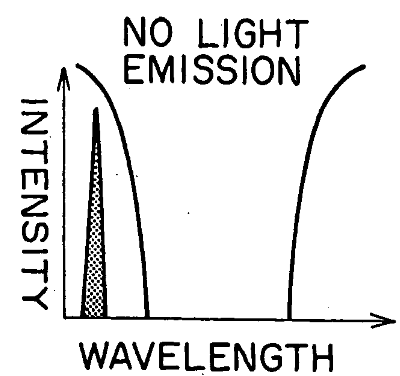


FIG.36A

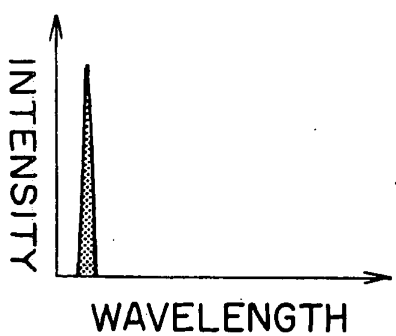


FIG.36B

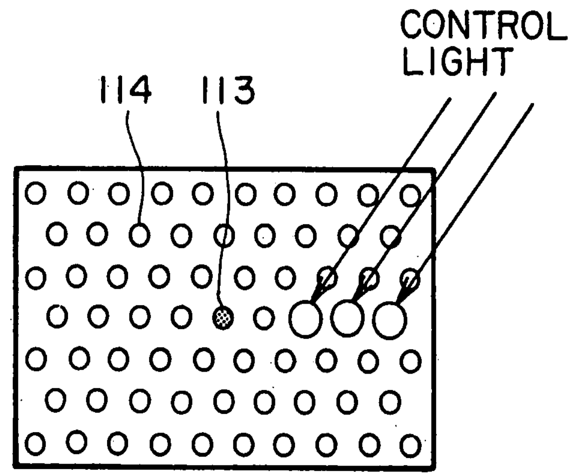


FIG.36C

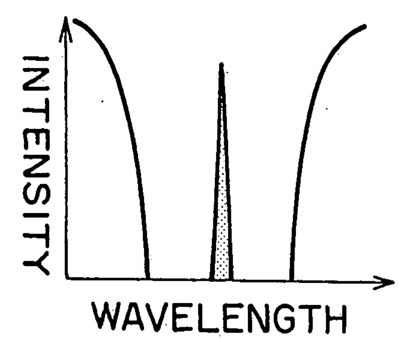
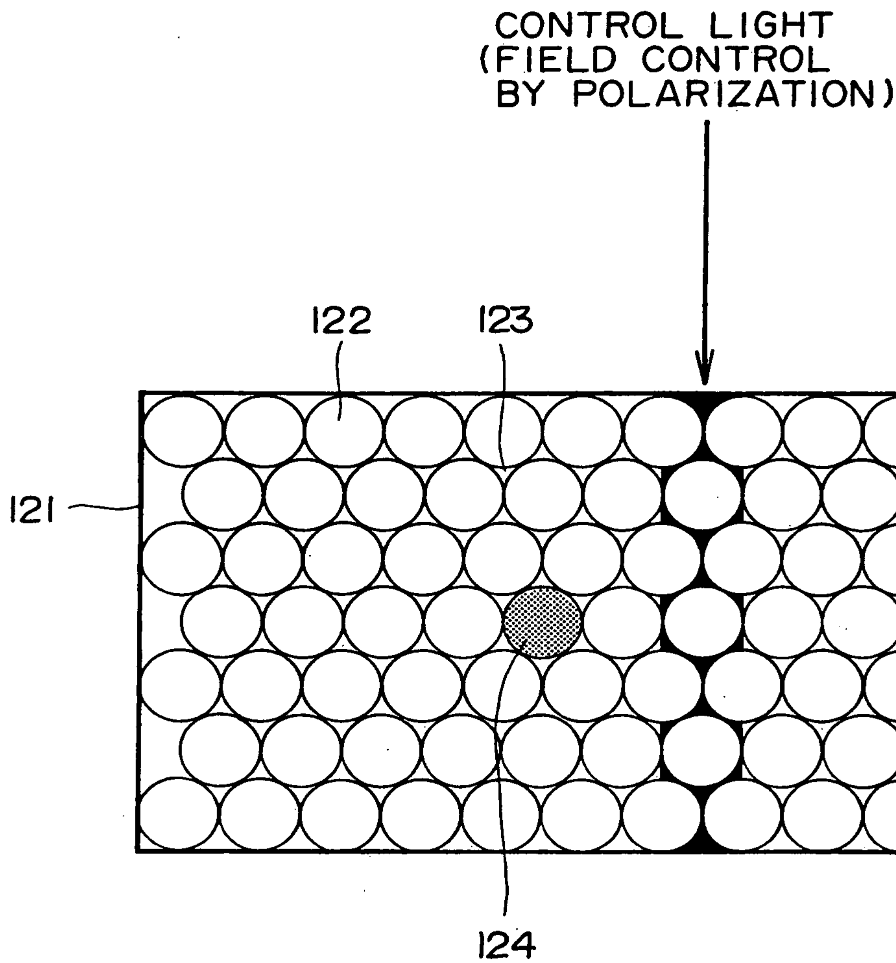


FIG. 37



CONTROL LIGHT
(FIELD CONTROL
BY POLARIZATION)
122
123
121
124